2003 January 14 document Excavation of the first stars

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abstract The external pollution of the first stars in the Galaxy is investigated. The first stars were born in clouds composed of the pristine gas without heavy elements. These stars accreted gas polluted with heavy elements while they still remained in the cloud. As a result, it is found that they exhibit a distribution with respect to the surface metallicity. We have derived the actual form of this distribution function. This metallicity distribution function strongly suggests that the recently discovered most metal-deficient star HE0107-5240 with [Fe/H]$= -5.3$ was born as a metal-free star and accreted gas polluted with heavy elements. Thus the heavy elements such as Fe in HE0107-5240 must have been supplied from supernovae of later generations exploding inside the cloud in which the star had been formed. The elemental abundance pattern on the surface of stars suffering from such an external pollution should not be diverse but exhibit the average pattern of numerous supernovae. Future observations for a number of metal-deficient stars with [Fe/H]< -5 will be able to prove or disprove this external pollution scenario. Other possibilities to produce a star with this metallicity are also discussed.